International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.9, No.05 pp 72-77, 2016

Water utilization efficiency as affected by soil moisture regimes, grains and rice varieties

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Abstract: A field experiment was conducted to study the effect of soil moisture regimes on varieties and grain yield on water utilization efficiency.
The important results can be summarized in the following :
The highest values of grain yields were obtained under the higher soil moisture regime of M1 followed by M2 and M3 in decreasing order.
The highest utilization efficiency (WUE) values of irrigation water was obtained under the low soil moisture regime of M3 followed by M2 and M1 in decreasing order.
The amounts of irrigation water were 5800, 4800 and 4340 m^3/fed. at M_1, M_2 and M_3, respectively for Sakha 102 variety, while they were 7600, 6240 and 5600 m^3/fed. at M_1, M_2 and M_3 for Giza 176 variety, respectively.
Using Sakha 102 varitey and M2 will save 40.32 % of irrigation water. Generally, data revealed that water utilization efficiency were 0.70, 0.82 and 0.85 for Sakha 102 variety and 0.51, 0.60 and 0.62 for Giza 176 variety at M1, M2 and M3, respectively.
From the obtained results of the experiment, it could be established the superiority of variety Sakha 102 in growth, yield and nutrients uptake over the variety Giza 176 under the identical conditions.
Keywords: Water utilization efficiency, Grains, Soil Moisture, Fertilizer, Variety.

Introduction

Rice growing under different soil water levels prevailing under rainfed conditions have largely been ignored[1]. Water scarcity is considered is one from the main challenges of crop production in the arid and semi-arid regions.

Flooded conditions require large quantities of water than that the other crops, which is used net only for growth of rice plants but also as a management tool during cultivation[2]. The chemistry of soil managements is important to the nutrition of low/and rice and to the processes of soil formation in flooded and poorly drained roils.

In recent years intermittent irrigation regimes have been developed in some rice production regions in attempts to reduce volumes of irrigation water while some broken irrigation methods that are used to control tillers, to improve soil conditions or to maximize efficiency at harvest. Intermittent irrigation is aimed mainly at saving water. It was reported the intermittent application of irrigation water 1-5 days after the disappearance of applied standing water saved 25-50% of the irrigation water as compared to the continuous submergence of fields, without any adverse effect on rice yield [3,4]reported that it is not necessary to flood plant rice to obtain

grain at high yield and of high quality and moreover, that the efficiency of water use for grain production was higher in saturated soil culture than in flooded rice production.

[5]Found in their study on the effect of three submergence depth of water (5,10 and 15 cm), and three nitrogen levels (15,30, and 45 kgN/fed.) on rice grain yield. They found that plant height total number of tillers, panicle length, 1000grain weight, rice grain yield, did not respond to the irrigation depths, the highest utilization efficiency of irrigation water was obtained with 5 cm submergence depth of water.

Many trails were done by many ways to overcome the negative effect drought on crops, an important way is the use of fertilizer on improving growth and yield under the abiotic stresses[6,7]. This research was conducted to study the effects of irrigation regimes affected on water use efficiency.

Material and Methods:

A field experiment was conducted in El Kanater station during to study the effect of soil moisture regimes and different sorts and rates of fertilizers on yield and nutrients content in rice plants. The experimental design was split plot with three replications, irrigation treatments were in the main plots, while the sub-plots were assigned to nitrogen treatments.

Soil samples at a depth of (0-03cm) from the surface layer of clay loam soil has a pH of 7.96; 1.8% O.M; 2.7% CaCo3; 26.7% sand, 39.6% silt and 33.7% clay. A total of 45 plastic post, contain air dried soil were arranged in a complete randomize design.

The irrigation treatments were used as follow:

M1: Watering at every 4 days irrigation intervals raising the submergence head to 5 cm at first month, 10 cm at the second month and 7 cm at the third month during irrigation.
M2: Watering at every 6 days irrigation intervals raising the submergence head to 5 cm at first month, 10 cm at the second month and 7 cm at the third month during irrigation.
M3: Watering at every 8 days irrigation intervals raising the submergence head to 5 cm at first month, 10 cm at the second month and 7 cm at the third month during irrigation.

Cultural practices:

Rice varieties Sakha 102 and Giza 176 were planted in the season 1999. Dates of planting nurseries, transplanting and harvesting were as follows :

Varieties

Practice	Sakha 102	Giza 176
Seeding	24 May	24 May
Transplanting	21 June	21 June
Harvesting	25 September	20 October

Characters studied:

Yield

For harvest, plants in the outside border of the plot was first removed, then those in the remaining plot (3 x 3 m) were cut by hand and threshed. Rice grains and straw yield of the two varieties obtained from each plot was separately determined and chemically analyzed (determination was carried out as described by[8,9]. Statistical analysis were performed using the least significant difference L.S.D) method at 1% and 5% according to[10].

Measurements:

a. **Irrigation water :**

A water pumb with a calibrated meter was used for measuring the amount of water delivered to each plot. Irrigation treatments were started 15 days after transplanting (after seeding establishment).

b. **Water use efficiency** (Kgs grains/cubic meter of water applied) was computed.

Results and Discussion:

Water Utilization Efficiency for the two rice varieties

Data of rice yield (kg/fed.) in relation to the amount of irrigation water delivered (m^3/fed.) are given by water utilization efficiency as shown in table (1& Fig.1). The amount of irrigation water (m^3/fed.) was affected by soil moisture regimes and rice varieties. Regardless the effect of rice varieties, the highest amount of irrigation water requirement for the two varieties was watering at every 4 days (M_1) followed by watering at every 6 days (M_2) and watering at every 8 days (M_3). The amounts of irrigation water were 5800, 4800 and 4340 m^3/fed. at M_1, M_2 and M_3, respectively for Sakha 102 variety, while they were 7600, 6240 and 5600 m^3/fed. at M_1, M_2 and M_3 for Giza 176 variety, respectively. These results agreement with those by [11,4]who stated that water use productivity increased by 75% ETc and tended to decrease with the increase in ETc% (100%) while the 50% ETc treatment was in between.

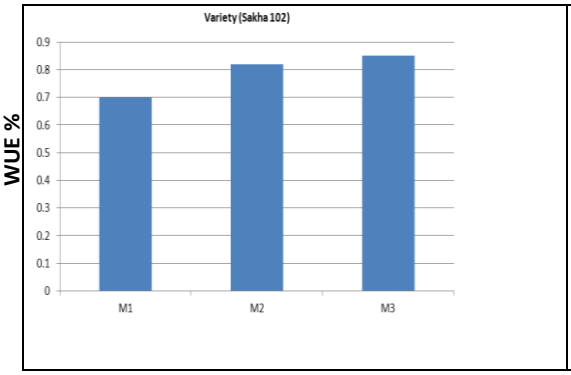
Table (1): Amount of irrigation water (m^3/ feddan) delivered to each treatment and number of irrigation of the two varieties.

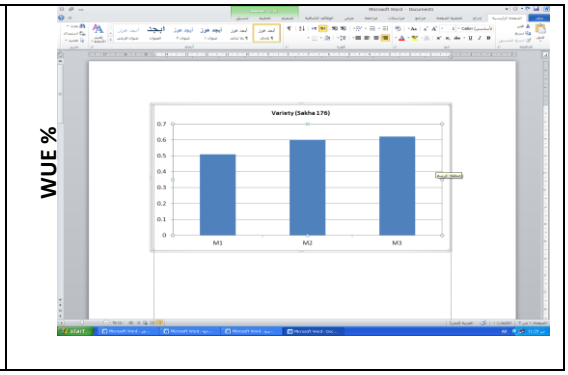
Varieties	Irrigation treatments	Number of Irrigation	Rice grain yield (kg/fed.)	Total amount of Irrigation water (m3/fed.)	Water utilization efficiency
Sakha (102)					
	M_1	19	4060	5800	0.70
	M_2	13	3929	4800	0.82
	M_3	10	3679	4340	0.85
Giza (176)					
	M_1	25	3856	7600	0.51
	M_2	17	3729	6240	0.60
	M_3	13	3447	5600	0.62

M_1 : Watering at every 4 days irrigation intervals raising the submergence head to 5 cm at the first month, 10cm at the second month and 7 cm at the third month.

M_2 : Watering at every 6 days irrigation intervals raising the submergence head to 5 cm at the first month, 10cm at the second month and 7 cm at the third month.

M_3 : Watering at every 8 days irrigation intervals raising the submergence head to 5 cm at the first month, 10cm at the second month and 7 cm at the third month.





Cubic meter/fed	Cubic meter/fed

Fig (1): Water utilization efficiency as affected by soil moisture regimes, grains and rice varieties.

Using M_2 or M_3 soil moisture regimes will save 17.24 and 25.17%, respectively for Sakha 102 variety, but it will save 17.89 and 26.32% for Giza 176 variety of the amount of water requirements. These results are in agreement with those by Hussiein and Siam (2014), who stated that water use efficiency (WUE) gave its higher values (fresh matter yield) under withholding 4th the irrigation at D_2. While the lowest values by fresh matter yield in regular irrigation while the D1 (withholding 2nd irrigation treatment was in between).

[5]Found in their study on the effect of three submergence depths of water (5, 10 and 15 cm), and three nitrogen levels (15, 30 and 45 kg N/ fed.) on rice grain yield. They found that plant height, total number of tillers, panicle length, 1000-grain weight, rice grain yield, did not respond to the irrigation depths, while the three nitrogen levels caused a high significant positive effect on all the prementioned characters. The highest utilization efficiency of irrigation water was obtained with 5 cm submergence depth of water.

The amount of irrigation water was affected also by rice varieties. The highest amounts of irrigation water requirements for all soil water regimes M_1, M_2 and M_3 were at using Giza 176 variety than Sakha 102 variety. Also, genetic improvement in water uptake ability and/or water use efficiency WUE of rice cultivars is one option to enhance productivity under water-limited condition[12].

Using Sakha 102 variety instead of Giza 176 variety will save 23.68, 23.08 and 22.8% of the amount of water requirements at M_1, M_2 and M3, respectively. Genotypes recorded significantly higher grain yield under stress as well as well watered conditions. The study led to the identification of promising trait donor genotypes which can be exploited in breeding to develop superior trait pyramided cultivars suitable for semi irrigated aerobic cultivation[13].

Using Sakha 102 variety and M_2 will save 38.32% of irrigation water requirements and the grains yield will decrease with 3.23%. If we cultivated one million feddan by Sakha 102 variety and watering at every 6 days will save 1000 million m^3 water every year using for irrigation in the new soils.

$$\textbf{WUE:} \quad \frac{\textbf{Rice grain yield (kg/fed.)}}{\textbf{Amount of irrigation water (m}^3\textbf{/fed.)}}$$

Data in the table also reveal that water utilization efficiency were 0.70, 0.82 and 0.85 for Sakha 102 variety at M_1, M_2 and M_3, respectively and 0.51, 0.60 and 0.62 for Giza 176 variety at M_1, M_2 and M_3, respectively. [14]Found that grain yield did not significantly differ when rice was irrigated every 3 or 6 days. However, yield decreased by less than 5% with irrigation every 6 days but about 17% of water consumption was saved. He also found that water use efficiency was greatest with irrigation every 6 days. Also, [15]observed WUE was higher in D_1 25% in ETc irrigation on condition and the lowest in full irrigation.

Data revealed that water utilization efficiency were 0.70, 0.82 and 0.85 for Sakha 102 variety and 0.51, 0.60 and 0.62 for Giza 176 variety at M1, M2 and M3, respectively.

Water management:

Intensifying rice cultivation could have various impacts on the environment. If good irrigation and drainage are provided, improved rice cultivars may be introduction, along with better management of fertilizer, weeds and pests [16,17]stated that the construction of dams, and of irrigation and drainage canals, would normally bring more benefits than disadvantages to the regional environment, as long as they are properly planned and implemented. It improves water use efficiency, regulates floods and draughts, and, though theses, improves the environmental quality. Also [18]found that spring application generally results in lower loading than fall application and crop yield may not be adversely affected. Precipitation is another factor that clearly affects nitrate leaching and concentration under corn/soybean production. [19]mentioned that drip irrigation system was more efficient for improving water use efficiency and N uptake from fertilizer in addition to potentially reduced leaching losses.

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